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EFFICIENCY INDICATORS FOR EDUCATION AND TRAINING

Norbert Lukasczyk

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THESIS

EFFICIENCY INDICATORS FOR EDUCATION AND TRAINING

by

NORBERT LUKASCZYK

June 1976

Thesis Advisor K. T. Marshall

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living index. They are applied to 60 courses of SSC San Diego and compared to indicators determined by linear regression based on the same data set. The resulting values of the indicators are helpful to locate the area of interest and detail for further decision making.

EFFICIENCY INDICATORS FOR EDUCATION AND TRAINING

by

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Lieutenant-Commander Federal German Navy
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Submitted in partial fulfillment of the
requirements for the degree of

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The indicators Staff Student Ratio, Cost per Student per Unit Time, and Cost per Graduate are discussed with emphasis on the analysis of their properties for the use as indicators for CNET to monitor efficiency of the training establishment both overall, and at different levels. The arguments show that the cost per graduate is the most appropriate indicator for a single course. Methods are derived to determine appropriate methods of aggregation for multiple courses. The derived indicators have the mathematical form of the Laspeyres and Paasch indicators, used in economic theory for the cost of living index. They are applied to 60 courses of SSC San Diego and compared to indicators determined by linear regression based on the same data set. The indicators are also applied for different groupings of courses, and different accounting systems. The resulting values of the indicators are helpful to locate the area of interest and detail for further decision making.

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I. INTRODUCTION

The purpose of this thesis is to propose and analyze certain indicators of education and training efficiency for the Chief of Naval Education and Training (CNET). CNET is seeking a set of indicators that will enable them to

- monitor the efficiency of the training establishment between given time periods,
- monitor the efficiency at various levels of aggregation such as
  - all activities of CNET,
  - all courses of an activity,
  - all courses belonging to a defined group, such as A schools or C schools,
  - all courses with common features such as course length etc.

The term efficiency is defined by CNET in the following way:

> Efficiency is the achievement of a _given training product_ at the _minimum expenditure_ of total training _resources_ within operational constraints.

It is not the purpose of this thesis to propose methods of measuring educational output or effectiveness of trained people on the job. These very important and difficult areas are beyond the scope of this work. Rather, we take the output of a trained person to be a constant, and develop indicators to measure how efficiently CNET is producing this given output in a given time period relative to previous time periods. Thus there is no attempt to measure an absolute level or magnitude of efficiency. The desired indicators are limited to measure changes in the corresponding magnitudes of resources from one time period

to the next.

In chapter 2 the indicators Student Staff Ratio, Cost per Student per Unit Time, and Cost per Graduate are dicussed for a single course, emphasizing the analysis of their properties. The arguments conclude that the Cost per Graduate is the preferred measure of efficiency. This measure is then developed for use with multiple courses.

In chapter 3 the cost per graduate indicators are applied to data collected from SSC San Diego and compared to a statistical approach. Chapter 4 gives a discription of the accounting system used in the cost report [2,3], from which the data was obtained. In chapter 5 the final conclusions and summary are made that the derived indicators fulfill the purposes of CNET. In appendix A the detailed listings, plots, and analysis of the data are given.

II. THEORETICAL APPROACH

A. SINGLE COURSE

We begin the development of indicators by looking at a single course, and investigate three measures of efficiency in light of the objectives of CNET. These are:

Staff Student Ratio,
Cost Per Student Week,
Cost per Graduate.

Our arguments conclude that only the last one is usable as a measure of efficiency.

1. Staff Student Ratio

One resource in education and training is the active staff. A common measure in educational instituitions is the ratio

$$\frac{\text{number of staff}}{\text{number of students}}$$

called the Staff Student Ratio.

An increase of the ratio indicates for a fixed staff input that fewer students have been trained in a given period, and this is usually taken to reflect a decrease in resource utilization. On the other hand a decrease of the ratio is usually taken to reflect an improvement of utilization of the same staff.

In many civilian instituitions such as universities, colleges, public schools, etc. the teaching potential is a

major input and the Staff Student Ratio in successive time periods is often used as an overall efficiency indicator. However modern education and training methodologies and techniques, especially those used in Navy technical training, often substitute computers or other aids to instruction. These can lead to an increase in overall efficiency, but also increase the Staff Student Ratio at the same time. Consider the following two situations:

Situation A. The required course objectives can be achieved by using the normal lecture type process under the following conditions: one staff member can instruct thirty students in two weeks with no technical support.

With the growing use of selfpaced, individualized computer aided methods, a 50% reduction in course length might be possible. Thus let us assume that by introducing new technology we have

Situation B. Two staff members can instruct thirty students in one week using thirty computer terminals.
The Staff Student Ratios for situation A and B are 1/30 and 1/15 respectively, indicating a 50% decrease in efficiency.

However, let us take a more careful look. Assume that a staff member is paid $300 per week, and a student $200 per week. In situation A, if all students successfully complete the course in two weeks then the cost per graduate will be

$$[(200 * 2 * 30) + 2 * 300] / 30 = \$420.$$

In situation B it is easy to see that if the computer costs are less than $200 per week the cost per graduate will be less than $420. Clearly the Staff Student Ratio gives misleading results caused by a basic change in the technology of teaching.

2. Cost per Student per Unit Time

The next indicator investigated is the Cost per Student per Unit Time. Although not as widely used as the Staff Student Ratio it still finds acceptance as a measure of education and training efficiency.

Let us consider our two situatuions again and assume the following parameters:

Situation A:		Situation B:	
Staff	300$/man week	Staff	300$/man week
Student	200$/man week	Student	200$/man week
Technical Support	none	Technical Support	100$/man week.

The cost per student week under situation A is $210, and under B is $320, whereas the cost per graduate is $420 and $320 respectively. Thus the Cost per Student per Unit Time indicator also gives misleading results.

3. Cost per Graduate

The training and education process in a given course can be thought of as in Fig 2.

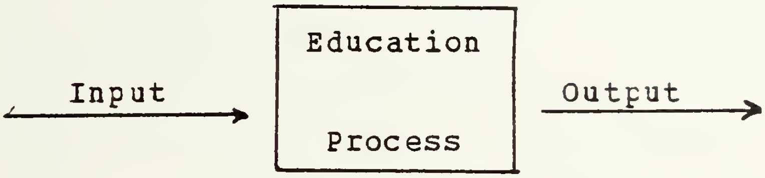


Figure 1 - The Input Output Process

The resources enter the process and produce a certain output. The preferred measure of efficiency is resources divided by output. The total resources are usually measured in dollars. The output is more difficult to measure in educational systems. Recall that we assumed that quality of output remains constant. Let us define the output in a given time period to be

$$\frac{\text{Total man months trained}}{\text{Course length}} \tag{1}$$

and call this the total number of graduates produced in a given period. The reader should realize that this number may not agree with the number who formally graduate due to missmatches of the course timing and the accounting period. However, the term graduates used here does measure the output of the education process. It follows that the appropriate measure to use for a single course is the cost per graduate. In the remainder of this thesis the term graduate will be used in the sense of equation (1).

Let c(t) be the cost of resources necessary to produce one graduate in time period t, called the cost per graduate. A useful measure is one which compares efficiency

in two successive time periods. Therefore let us take the ratio between the costs per graduate of the time periods. The indicator has the form

(2) $$I(t-1,t) = c(t) / c(t-1),$$

where the period t-1 is used as base. The indicator reflects mainly three situations:

i) $c(t) > c(t-1)$ then $I(t-1,t) > 1$ indicating that the efficiency decreased since the cost per graduate grew.

ii) $c(t) = c(t-1)$ then $I(t-1,t) = 1$ indicating that the efficiency is unchanged.

iii) $c(t) < c(t-1)$ then $I(t-1,t) < 1$ indicating an increase in efficiency since the cost per graduate decreased.

Thus the cost per graduate ratio reflects the changes of efficiency in the correct way. All resources can be included if they are representable in cost units. It is invariant to unit changes since those would be applied to numerator and denominator and cancel out in the division. It has the time reversal property

$$I(t-1,t) = 1 / I(t,t-1),$$

that is by changing the base period, one indicator is merely the reciprocal of the other. For example, if $I(t-1,t) = 0.8$, then $I(t,t-1) = 1.25$, which shows that if the cost per graduate in period t was 80% of that in t-1, then in t-1 it was 125% of what it was in period t. Changes in efficiency as shown by the example should be easily understood and meaningful to people not familiar with the development of the indicator.

B. MULTIPLE COURSES

After developing the cost per graduate ratio as an indicator for a single course the problem now is how to

combine these indicators to obtain a meaningful indicator reflecting efficiency changes in a group of courses. In what follows the set A represents a group of n (≥1) courses. Two approaches are discussed. In the following Σ means $\sum_{i \in A}$.

First, let $I_i(t-1,t) = c_i(t) / c_i(t-1)$ be the indicator for the single course i as in equation (2). Let w_i be a weight attached to course i, and define

$$(3) \qquad I(t-1,t) = \Sigma I_i(t-1,t) w_i$$

where $\Sigma w_i = 1$, $w_i \geq 0$. We call this the weighted average approach.

For the second approach let $x_i(t)$ be the number of graduates from course i in period t. The total cost of the group in period t is $\Sigma c_i(t) x_i(t)$. Let e_i be a weight associated with the graduates of course i which reflects differences in graduates from different courses. The total number of "equivalent" graduates in period t is $\Sigma x_i(t) e_i$. Define $c(t) = \Sigma c_i(t) x_i(t) / \Sigma x_i(t) e_i$, the cost per equivalent graduate in period t. Then let the efficiency indicator bee the ratio

$$I(t-1,t) = c(t) / c(t-1).$$

We call this the equivalent graduate approach.

1. Weighted Average Approach

The simplest form of weighted average is to take the arithmetic mean. Recall that n is the number of elements in

A and set $w_i = 1/n$ for all i. Then

$$I(t-1,t) = 1/n \sum c_i(t)/c_i(t-1).$$

The courses might be of equal importance to the Navy, but may not be equal in their utilization of resources. Thus they should influence the efficiency differently. The following example will demonstrate this. Consider two courses i = 1,2 for periods t-1 and t, and assume the parameters for

period t-1	period t
$c_1(t-1) = 100$	$c_1(t) = 100$ \$/grad
$x_1(t-1) = 10$	$x_1(t) = 10$ grad
$c_2(t-1) = 1200$	$c_2(t) = 1000$ \$/grad
$x_2(t-1) = 15$	$x_2(t) = 12$ grad

The resulting overall indicator is

$$I(t-1,t) = 1/2[(100/100)+(1000/1200)] = 1/2[1+.833] = .917$$

Since the use of resources shown by the cost per graduate of course 2 is almost ten times that of course 1 the change in effiency of course 2 is expected to contribute more to the overall efficiency than an equal share. Our intuitive expectation about the overall indicator would be

$$(1 + 10 * 8.33)/ 11 = .85.$$

Thus let us construct other weights which agree more closely with our intuition.

One way to weight the courses is to take their amount of output into consideration and relate it to the total course group output, that is let

$$w_i = x_i(t) / \sum x_i(t)$$

where $\sum w_i = 1$, $w_i \geq 0$. Thus

$$I(t-1,t) = \sum[c_i(t)x_i(t)/c_i(t-1)] / \sum x_i(t).$$

Applying the numeric example yields

$$I(t-1,t) = (10 + 10)/22 = .909,$$

which is a small improvement towards our intuitive expectation. We follow this line and take both the cost per graduate and the amount of output of the corresponding course into consideration. Let us use the relation of the total expenditures for course i to the total expenditures for the whole group in period t-1. Then

$$w_i = c_i(t-1)x_i(t-1)/\Sigma c_i(t-1)x_i(t-1)$$

where $\Sigma w_i = 1$, $w_i \geq 0$. Using these weights

$$I(t-1,t) = \Sigma c_i(t)x_i(t-1)/\Sigma c_i(t-1)x_i(t-1). \tag{4}$$

Applying our numeric example the overall efficiency change would be

$$I(t-1,t) = (1000 + 15000)/(1000 + 14400) = .842$$

which is close to our intuitive value.

The indicator in equation (4) has a mathematical form commonly found in economic theory. There it is known as the Laspeyres indicator and is used in the computation (see Wald[5]) or approximation (see Allen[1]) of the cost of living indicator. The properties of the cost of living index are similar to those properties desired for a CNET indicator.

Relating the economic interpretation of the indicator to the training and education situation the Laspeyres indicator reflects the relation between the total expenditures for the base period, here t-1, and the total expenditures which would have been caused by producing the output of period (t-1) in period t at period t costs, $c_i(t)$.

From this interpretation another form of an indicator comes to mind, one which relates the expenditures caused when producing the output of the current period at

last periods prices. This indicator is known in economic theory as the Paasch indicator

(5) $$I(t-1,t) = \Sigma c_i(t)x_i(t)/\Sigma c_i(t-1)x_i(t).$$

It is also used for the determination or approximation of the cost of living indicator (see Wald[5], and Allen[1]). To derive this form of the indicator the weights have to be

$$w_i = c_i(t-1)x_i(t)/\ \Sigma c_i(t-1)x_i(t)$$

where again $\Sigma w_i = 1$, $w_i \geq 0$. The numeric example would yield an overall efficiency indicator of

$$I(t-1,t) = (1000 + 14400)/(1000 + 12000) = .844$$

also close to the intuitive value.

2. Equivalent Graduates Approach

Until now the numbers of graduates of different courses were used in an equal fashion. But the question arises does the change in the number of graduates from one course cause the same effects as an equal change in the number of graduates from another course. To overcome this problem let us relate all course graduates to a common unit and determine their equivalence factors e_i. The total costs of the course-group could be related to the sum of equivalent graduates and the form of the indicator for the single course could be applied correspondingly to the group. When

(6) $$c(t) = \Sigma c_i(t)x_i(t)/\ \Sigma e_i x_i(t) \text{ then}$$

$$I(t-1,t) = c(t)/c(t-1) .$$

The problem is to find meaningful expressions for the equivalence factors e_i.

One way is to relate courses by their cost per graduate, that is let $e_i = c_i(t-1)$. The overall efficiency indicator will be then

$$I(t-1,t) = \frac{[\Sigma c_i(t)x_i(t) \quad \Sigma c_i(t-1)x_i(t-1)]}{[\Sigma c_i(t-1)x_i(t) \quad \Sigma c_i(t-1)x_i(t-1)]}$$

$$= \Sigma c_i(t)x_i(t) \; / \; \Sigma c_i(t-1)x_i(t),$$

which is equivalent to equation (5), the Paasch indicator. Thus setting $e_i = c_i(t-1)$ in (6) is equivalent to setting

$$w_i = [x_i(t)c_i(t-1)] \; / \; [x_i(t)c_i(t-1)]$$

in equation (3).

If we let $e_i = c_i(t)$ then

$$I(t-1,t) = [\Sigma c_i(t)x_i(t-1)] \; / \; [\Sigma c_i(t-1)x_i(t-1)]$$

which is equivalent to equation (4), the Laspeyres indicator. In relating this equation to (3) we obtain

$$w_i = \frac{[x_i(t)c_i(t-1)\Sigma c_i(t)x_i(t-1)]}{[\Sigma x_i(t)c_i(t)\Sigma c_i(t-1)x_i(t-1)]} .$$

Note that in this case $\Sigma w_i \neq 1$.

The indicators in both equations (4) and (5) are easily computable and understood, and both have desirable properties. For a detailed discription of these indicators see Allen[1] and Fisher[4].

Both indicators play a central role in the remainder of this thesis, and we use the following notation

$$L(t-1,t) = \frac{[\Sigma c_i(t)x_i(t-1)]}{[\Sigma c_i(t-1)x_i(t-1)]},$$

and

$$P(t-1,t) = \frac{[\Sigma c_i(t)x_i(t)]}{[\Sigma c_i(t-1)x_i(t)].}.$$

III. DATA ANALYSIS

In this chapter data of sixty different courses at the activity SSC San Diego are analysed. They are taken from the annual cummulative cost reports [3,4]. The data were collected during the time periods of 1974 and 1975, and are listed partially in Fig 2, and in appendix A. The data are grouped into the main group of all sixty courses and the two subgroups of thirtynine C-schools, and thirteen A-schools. For each group an anlysis is done with regard to the

- Total cost per graduate which includes all costs of resources which are considered to determine the total operating budget of a course.
- Direct cost per graduate which includes only costs accounted to the direct course and the corresponding overhead share.
- Indirect cost per graduate the difference between the two above including resources like hospital, housing, student salaries, etc.

More details about the different costs are given in the next chapter.

Applying the cost indicators derived in the last chapter to the data listed in Fig 2 the following results are determined. The single course indicators are given in the last column of Fig 2, their arithmetic mean yields 1.167 which is, as expected, much higher than the

Laspeyres indicator L = 1.081, and the

Paasch indicator P = 1.014.

Figure 2

TOTAL COST PER GRADUATE

COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
BOOST	P	14805.92	93.04	17203.46	63.20	1.16
NDT RAD OP	C	6402.84	54.38	5438.60	67.48	0.85
RM-B	B	5716.24	334.30	5559.39	391.44	0.97
IC-APSC	C	5084.15	47.60	5637.75	57.20	1.11
WELD NPPW	C	4707.92	116.54	5278.08	138.84	1.12
WELD NPPO	C	4504.52	64.72	4575.60	54.17	1.02
RM-A	A	3672.74	1296.10	3129.56	2840.69	0.85
DIVE SECOND	F	3334.52	197.45	3383.08	193.95	1.01
RM-TT MCC28	C	3163.11	268.24	4021.46	170.33	1.27
WELD FPHULL	C	3161.40	453.27	4423.12	480.52	1.40
RM-MORSE CD	C	3068.19	300.53	2872.53	534.38	0.94
NDT VMP	C	3006.82	86.97	3336.72	74.75	1.11
IC-A	A	2967.05	927.86	2373.89	1064.16	0.80
DRUG SPEC	C	2912.70	112.13	2540.83	96.23	0.87
AC & R	C	2888.64	323.51	2874.24	328.26	1.00
WELD HPPIPE	C	2880.03	263.08	3641.99	324.07	1.26
MR-A	A	2862.95	473.24	2806.80	505.39	0.98
HT-A-PH-2	A	2843.67	1633.11	2547.93	2393.85	0.90
INTER/CLASS	C	2642.81	97.85	2987.03	101.37	1.13
IC-APS MT	C	2621.43	14.00	2947.90	11.70	1.12
EM-A	A	2562.32	869.29	1729.00	1169.38	0.67
DP SYS ANA	C	2546.25	16.40	1994.80	32.00	0.78
ET-C	C	2483.32	996.10	6000.45	554.83	2.42
IC-NC2 MC-2	C	2234.80	56.20	3205.25	37.20	1.43
DP-A	A	2082.54	655.21	2472.07	466.43	1.19
DP IBM 360	C	1822.59	106.38	2416.88	75.19	1.33
DK ASCOL	A	1791.90	436.02	2363.76	70.00	1.32
YN-A	A	1782.67	614.25	1515.78	151.00	0.85
SK-A AFLT	A	1745.11	963.88	1095.39	307.54	0.63
NDT LSBI	C	1625.98	50.72	1571.40	47.75	0.97
SK-A ASH	A	1604.88	164.07	1492.19	27.28	0.93
PC-A SCOL	A	1562.96	106.59	1170.61	175.95	0.75
PN-A	A	1552.27	541.80	1431.43	124.29	0.92
DIV SCUBA	F	1247.24	162.32	1456.41	165.92	1.17
EERECS	P	1066.50	5419.08	1214.35	6721.31	1.14
DP FORTRAN	C	1025.72	9.75	2449.84	4.37	2.39
DP PRG ASSY	C	1024.44	4.25	1854.12	10.83	1.81
NDT RI-N	C	1020.57	23.00	1420.12	53.00	1.39
NDT RI C	C	1009.74	21.67	1727.24	6.50	1.71
GM-A	A	958.81	506.64	1447.91	288.45	1.51
INST-NAVRES	C	930.84	26.00	559.69	26.00	0.60
SH-C BARBER	C	915.88	166.19	1257.63	100.22	1.37
NDT RADSAF	C	910.22	8.50	1046.20	21.50	1.15
RM TT LLK	C	856.75	74.63	879.94	65.41	1.03
ADMIN/COUNS	C	817.90	399.53	1116.48	96.11	1.37
DP-SYS OPS	C	812.06	45.48	1064.56	12.00	1.31
SH-C CLERK	C	802.93	176.70	810.30	24.67	1.01
INST SHIPBD	C	744.03	452.51	850.70	217.51	1.14
IC-DRAI-DRT	C	689.19	50.67	987.60	47.67	1.43
EM WASH-EXT	C	688.96	78.25	738.94	97.50	1.07
AC&R CENTRL	C	664.42	95.51	750.78	78.00	1.13
MGMT/SUPV	C	658.51	1219.86	747.70	878.72	1.14
EM-16MM MT	C	632.12	221.00	781.64	177.50	1.24
SH-C LNDRY	C	517.36	56.50	723.34	65.00	1.40
RM QUAL CON	C	503.45	294.29	965.76	214.36	1.92
DRUG ADVISR	C	502.05	290.00	492.15	371.65	0.98
SK-FIN SYS	C	483.52	39.00	249.59	22.00	0.52
CSVETS	S	419.92	717.47	532.10	675.50	1.27
AC&R DRYAIR	C	401.77	96.44	381.06	17.00	0.95
SK-FOOD	C	326.78	95.00	604.18	22.00	1.85

The square root of P*L is an indicator which has the time reversal property (see Allen [1]), $\sqrt{P*L} = 1.047$.

This indicates an increase in costs of about 5% from period 1974 to period 1975.

In Fig 3 the sixty pairs of sample observations on the total cost per graduate [c(74),(75)] are represented on a scatter diagram. Assuming the $c_i(74)$ as fixed and the $c_i(75)$ as random variables a reasonable statistical model would be

$$c_i(75) = a + b\, c_i(74) + u_i \, ,$$

where a and b are parameters which have to be estimated based on the data, and u_i are error terms, which are assumed to be multivariate normally distributed with mean zero, variance v^2 and covariance zero.

Using the theory of simple linear regression the estimates for the parameters based on the data given in Fig 2 are, for the intercept and the slope:

$$a' = 52.69, \text{ and } b' = 1.083.$$

The r^2 value is 0.924 and indicates a very high correlation between the 74 and 75 data.

Due to the assumption about the u_i's the estimates a',b' as functions of u_i are also normally distributed and we can do a hypothesis testing on a and b as follows. Denote by c74 the mean value $E(c_i(74))$, and by l the level of significance. Then the 100(1-l) per cent confidence intervals for a and b respectively are

$$a' \pm t_{1/2}(v'\sqrt{\Sigma c_i(74)^2}) \,/\, \sqrt{n\ \Sigma(c_i(74)-c74)^2},$$

and

$$b' \pm t_{1/2}\ v' \,/\, \sqrt{n\ \Sigma(c_i(74)-c74)^2},$$

where $t_{1/2}$ is the corresponding value of the Student t distribution. For testing the joint hypothesis a=0 and b=1, the F value is determined and compared to the table value for the corresponding l level and degrees of freedom.

Applying this to the data of Fig. 2, the confidence intervals for the intercept a and slope b with l = 10% are

$$-151.61 < a < 256.80,$$

and

$$1.016 < b < 1.15.$$

The F value = 5.71.

The single hypothesis a=0 is accepted, since zero is in the interval. The single hypothesis b =1 is rejected, since it is outside the confidence interval. The joint test a=0, and b=1 is also rejected since the F value is greater than the corresponding table value $F_{(2,58)}(90) = 2.39$.

Taking the tested hypothesis into consideration, the line

$$c'_i(75) = b'\ c_i(74)$$

yields a good approximation to our data for $c_i(75)$, and the indicator derived from this model would be

$$I(74,75) = c'(75)/c(74) = b' = 1.083,$$

which is equal to the value determined by the Laspeyres indicator.

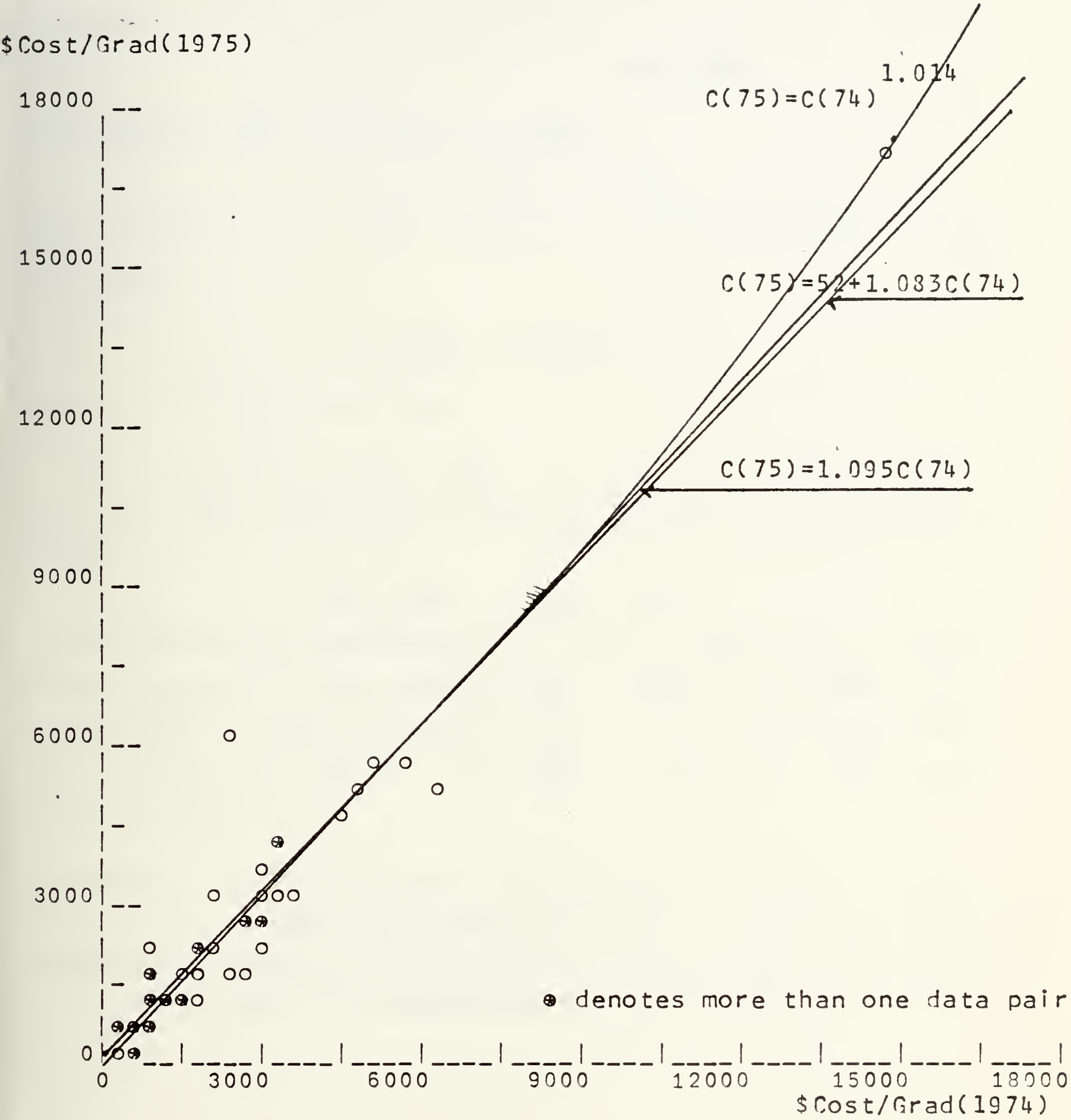


Figure 3 - Total Cost per Graduate 1974 vs 1975 for all sixty Courses

Since the most data pairs are squeezed in at the bottom end of the scale, they were also ploted on semi log scaling as shown in Fig 4 to investigate the model

$$\log(c_i(75)) = a + b \log(c_i(74))$$

The simple linear regression yields

$$a'=0.693 \text{ and } b'=0.921,$$

the value of $r^2 = .866$ indicates a good correlation, thus the model

$$c'_i(75) = 2\ c_i(74)^{.921}$$

is a good fit for the data.

The values expected for a' should be about zero. Therefore let us force a to be zero and investigate the model

$$\log c(75) = b \log c(74).$$

The regression determines b' = 1.014 in this case, a value which is equal to that given by the Paasch indicator. The corresponding curve is drawn in Fig. 3, at it's lower value part it is almost linear and bends slowly at very high values of c(74).

Thus in the value range of our investigation the linear model is a good approximation and is used for the statistical approach to determine b' as the cost efficiency indicator between the corresponding time periods.

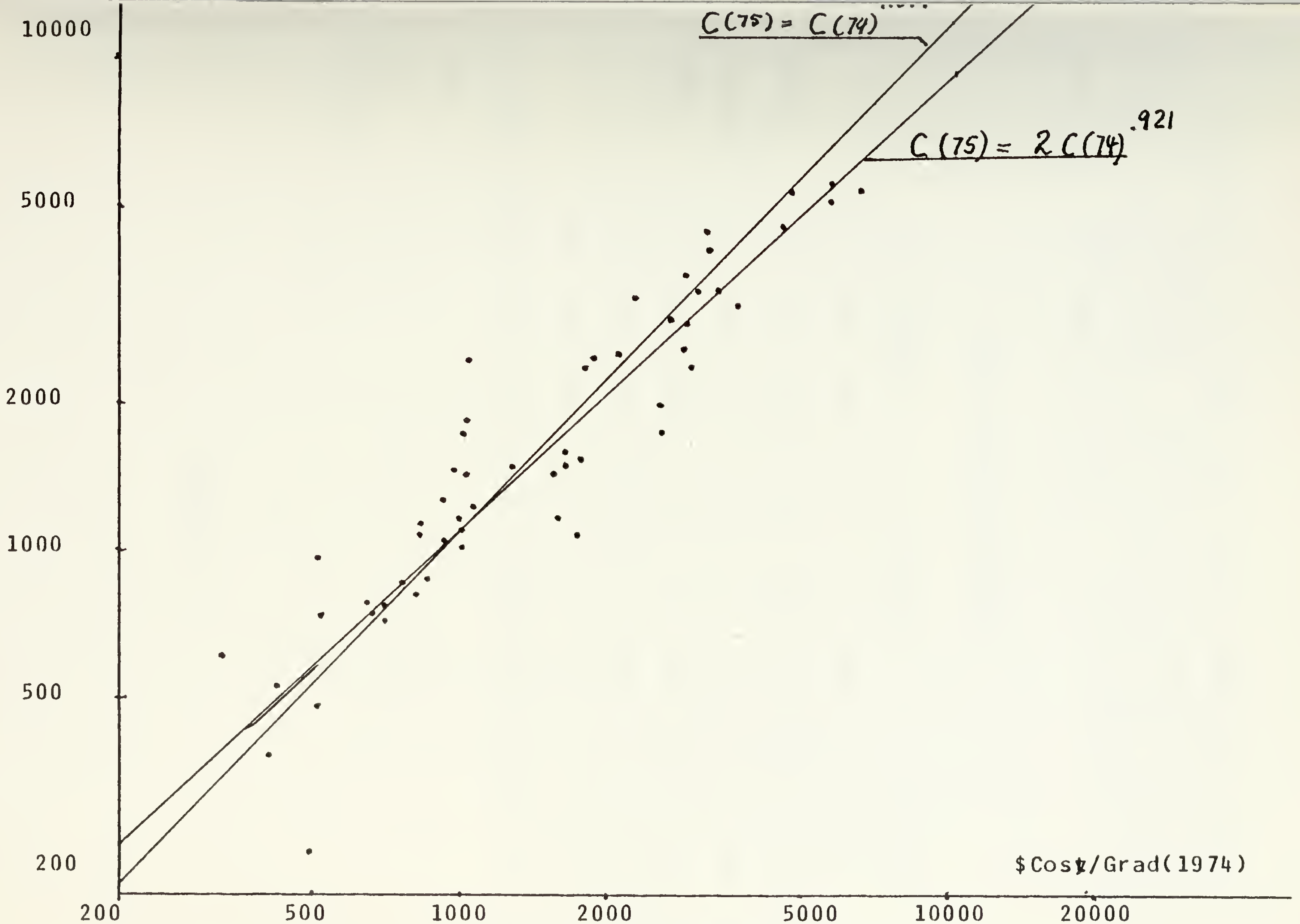


Figure 4 - Total Cost per Graduate 1974 vs 1975
for all sixty Courses on semi log Scale

In appendix A the reader can find the detailed listings, plots, and regression values for the three groups with regard to total-, direct-, and indirect cost per graduate. In Fig.5 a summary is given where + means acceptance of the hypothesis, and - means rejection.

DATA ANALYSIS SUMMARY

	ALL COURSES			C SCHOOLS			A SCHOOLS		
	TOTAL	DRECT	INDRT	TOTAL	DRECT	INDRT	TOTAL	DRECT	INDRT
Paasch	1.014	1.146	0.968	1.290	1.498	1.192	0.860	0.932	0.839
Laspeyres	1.081	1.303	1.004	1.409	1.725	1.256	0.882	0.994	0.849
$\sqrt{P*L}$ =	1.047	1.222	0.986	1.348	1.608	1.224	0.871	0.963	0.844
a'	52.69	13.16	115.8	325.8	176.2	199.5	424.3	114.6	264.6
b'	1.083	1.265	0.956	1.003	1.017	0.951	0.717	0.807	0.717
Cor.Fact.	0.924	0.806	0.936	0.822	0.686	0.834	0.664	0.677	0.625
H:a=0	+	+	+	-	-	-	+	+	+
H:b=1	-	-	+	+	+	+	-	+	-
H:a=0,b=1	-	-	+	-	-	-	-	+	-

Figure 5

IV. ACCOUNTING SYSTEM

The values computed for the indicators with regard to the total-, direct-, and indirect cost per graduate among the group of all sixty courses or the subgroups of A-schools, and C-schools vary remarkably, indicating cost increases as well as decreases. Therefore let us take a close look at the costs and the way they are determined.

The data used in chapter 3 are taken from the the school cost report[2,3]. The total cost per graduate for a single course is determined by the sum of the direct cost per graduate and the indirect cost per graduate, and thus includes all resources listed in that report. The direct cost is aggregated from the following single resource cost:

Resource name	Abreviation
Direct course costs	NameDir
Command level overhead	C/A
Division level overhead	Div
Group level overhead	Group

The *indirect cost* includes the following resource costs:

Resource name	Abreviation
CNET share	CNNT
Host activity	Host
Hospital	Hosp
Family housing	Fam
Equipment depreciation	Eq.Dep.
Activity staff travel	Act.Stf.Trv.
Student travel	Stu.Trv.
Student salaries	Stu.Sal.

The *cost of a single resource* is broken into the following categories:

military labor	ML
civilian labor	CL
supply costs	SC
contract costs	CC
miscellaneous costs	MC

The listing and summation for a single course is illustrated by the following example. Data are taken from the Dive Second school in 1974. The horizontal summation yields the resource subtotal, the vertical summation yields the cost factor subtotal for the direct cost level, which summed horizontally yield the course direct cost.

Course Name:	ML	CL	SC	CC	MC	Total	
Dive Se Dr			33362	225	4038	37625	
C/A	36967	2395	1429	881	1091	42763	
Div	4173	1081	10		234	5498	
Group	125272		503		881	126656	
							+
Direct Cost	166412	3476	35304	1105	6244	212542	
per grad.						1076.4	
CNNT	2341				2176	4517	
Host	39337				36249	75586	
Hosp	1900				700	2600	
Fam					200	200	
Eq.Dep					800	800	
Stu.Trv.					300	300	
Stu.Sal	100500					100500	
							+
Indirect c.	352168	3476	35304	1105	85094	477147	
per grad.						2416.6	
							+
Total cost						689689	
per grad.						3492.9	

V. CONCLUSIONS AND SUMMARY

In chapter 2 cost efficiency indicators are derived, and their properties analyzed. They have the mathematical form equivalent to the Laspeyres and Paasch indicators, known in economic theory and used to determine the cost of living index. In chapter 3 the indicators are applied to data from sixty courses of SSC San Diego. The same data is analyzed using linear regression.

The indicator for the total cost per graduate for all courses is 1.047 with the Laspeyres and Paasch having 1.081 and 1.014. Note that the slope of the line in Fig. 3 that passes through the origin is 1,095 and the linear regression line has slope 0.083. All these indicate a cost increase in the range of the inflation rate. Due to the similarity in the overall trend and the magnitude, one is tempted to explain the decrease in efficiency by these influences. However, by looking at the values for the subgroups of A courses and C courses or for direct-, and indirect cost per graduates we see that this conclusion is not valid.

The reader should remember that the purpose of a single indicator is to determine an overall trend. The form of aggregation used makes detailed conclusions about which resource causes what effect difficult.

One way to get more detailed information on the area of resources or courses causing the change in efficiency is by separating the costs and using different aspects of accounting, or by grouping courses due to their features, or membership at locations. Examples are given in chapter 3.

The direct cost per graduate for the whole group yields indicators reflecting a 15% to 25% decrease in efficiency whereas the indirect cost per graduate yields indicators reflecting almost no change. Applying the indicators to the subgroups shows an increase of efficiency in the A schools and a decrease in the C schools. Thus attention should be directed to these groups to find out the reasons to make further decisions.

As a summary we can say that the derived indicators are able:

- to monitor the efficiency of the trainig establishment, and to do this at different levels of accounting or grouping.

Thus they are usable for the purposes of CNET.

APPENDIX A

DETAILED DATA ANALYSIS

In this appendix the reader can find the detailed listings of the data taken from the cost report [2,3], the scatter diagrams plotting the corresponding cost per graduate of period 74 versa period 75, the computed indicators derived in chapter 2, the parameters determined by applying simple linear regression, and the corresponding confidence intervals and F values. The sequence of listings, plots, and data are:

Total cost per graduate
listing of all sixty courses,
plot of these data pairs,
listing of thirteen A schools,
plot of these data pairs,
listing of forty C schools,
plot of these data pairs,
computed values.

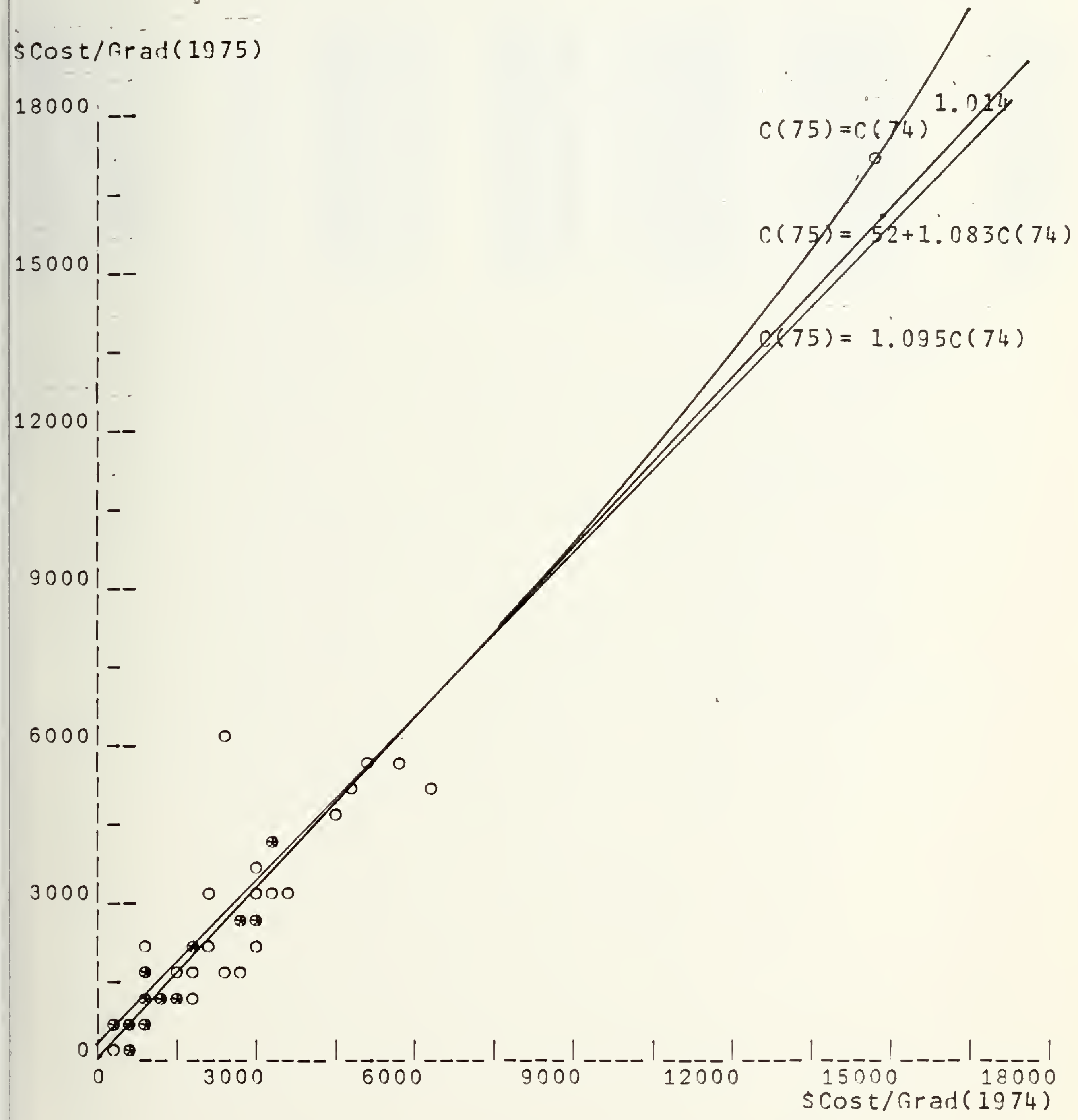
Direct cost per graduate
listing of all sixty courses,
plot of these data pairs,
listing of thirteen A schools,
plot of these data pairs,
listing of forty C schools,
plot of these data pairs,
computed values.

Indirect cost per graduate

listing of all sixty courses,
plot of these data pairs,
listing of thirteen A schools,
plot of these data pairs,
listing of forty C schools,
plot of these data pairs,
computed values.

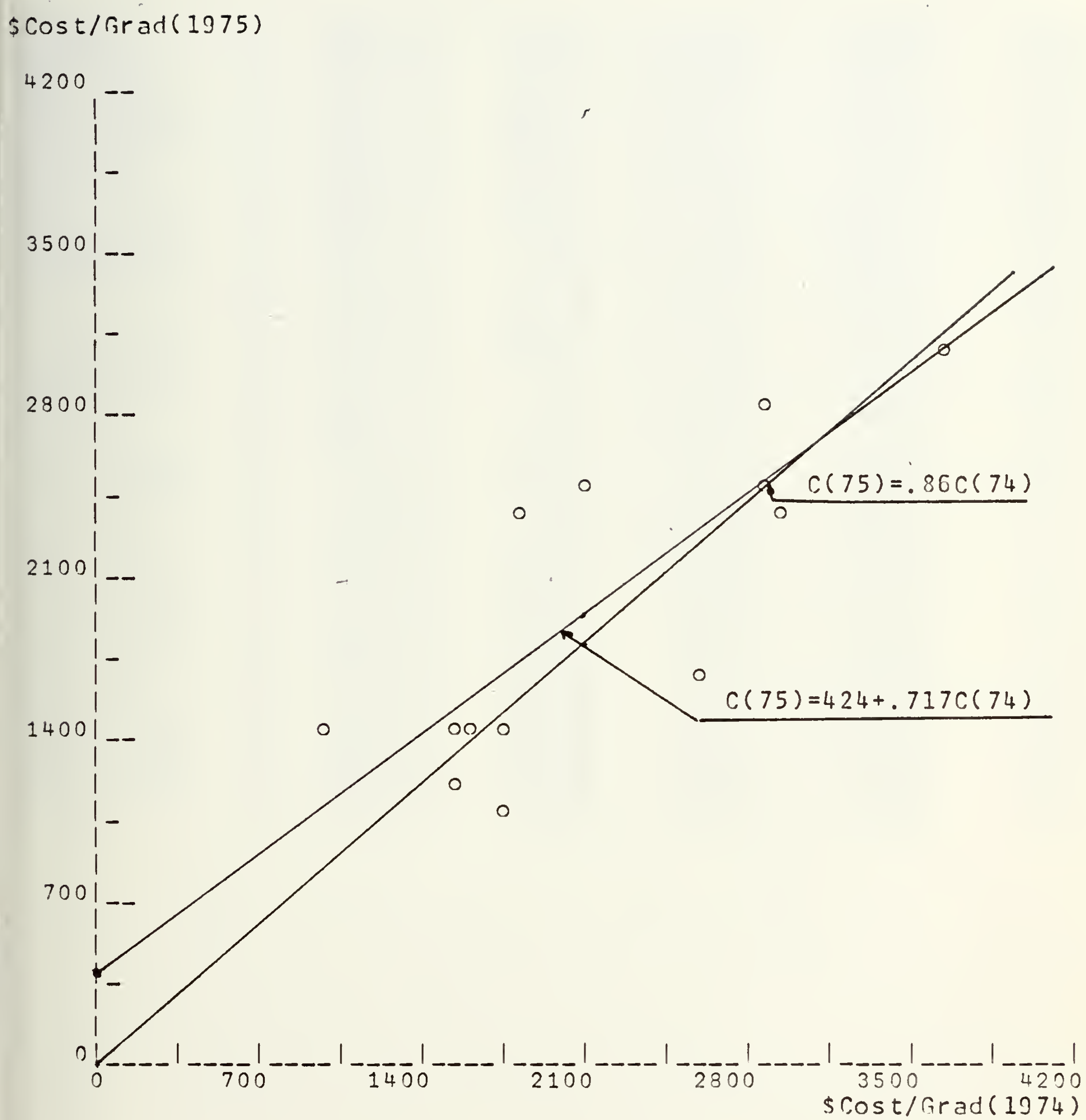
TOTAL COST PER GRADUATE

COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
BOOST	P	14805.92	93.04	17203.46	63.20	1.16
NDT RAD OP	C	6402.84	54.38	5438.60	67.48	0.85
RM-B	B	5716.24	334.30	5559.39	391.44	0.97
IC-APSO	C	5084.15	47.60	5637.75	57.20	1.11
WELD NPPW	C	4707.92	116.54	5278.08	138.84	1.12
WELD NPPC	C	4504.52	64.72	4575.60	54.17	1.02
RM-A	A	3672.74	1296.10	3129.56	2840.69	0.85
DIVE SECOND	F	3334.52	197.45	3383.08	193.95	1.01
RM-TT MOD28	C	3163.11	268.24	4021.46	170.83	1.27
WELD FPHULL	C	3161.40	453.27	4423.12	480.52	1.40
RM-MORSE CD	C	3068.19	300.53	2872.53	534.38	0.94
NDT VMF	C	3006.82	86.97	3336.72	74.75	1.11
IC-A	A	2967.05	927.86	2373.89	1064.16	0.80
DRUG SPEC	C	2912.70	112.13	2540.83	96.23	0.87
AC & R	C	2888.64	323.51	2874.24	328.26	1.00
WELD HPPIPE	C	2880.03	263.08	3641.99	324.07	1.26
MR-A	A	2862.95	473.24	2806.80	505.39	0.98
HT-A-PH-2	A	2843.67	1633.11	2547.93	2393.85	0.90
INTER/CLASS	C	2642.81	97.85	2987.03	101.37	1.13
IC-APS MT	C	2621.43	14.00	2947.90	11.70	1.12
EM-A	A	2562.32	869.29	1726.00	1169.38	0.67
DP SYS ANA	C	2546.25	16.40	1994.80	32.00	0.78
ET-C	C	2483.32	996.10	6000.45	554.83	2.42
IC-NC2 MD-2	C	2234.80	56.20	3205.25	37.20	1.43
DP-A	A	2082.54	655.21	2472.07	466.43	1.19
DP IBM 360	C	1822.59	106.38	2416.88	75.19	1.33
DK ASCOL	A	1791.90	436.02	2363.76	70.00	1.32
YN-A	A	1782.67	614.25	1515.78	151.00	0.85
SK-A AFLT	A	1745.11	963.88	1095.39	307.54	0.63
NDT USBI	C	1625.98	50.72	1571.40	47.75	0.97
SK-A ASH	A	1604.88	164.07	1492.19	27.28	0.93
FC-A SCOL	A	1562.96	106.59	1170.61	175.95	0.75
PN-A	A	1552.27	541.80	1431.43	124.29	0.92
DIV SCUBA	F	1247.24	162.32	1456.41	165.92	1.17
EERECS	P	1066.50	5419.08	1214.35	6721.31	1.14
DP FORTRAN	C	1025.72	9.75	2449.84	4.37	2.39
DP PRG ASSY	C	1024.44	4.25	1854.12	10.83	1.81
NDT RI-N	C	1020.57	23.00	1420.12	53.00	1.39
NDT RI C	C	1009.74	21.67	1727.24	6.50	1.71
CM-A	A	958.81	506.64	1447.91	288.45	1.51
INST-NAVRES	C	930.84	26.00	559.69	26.00	0.60
SH-C BARBER	C	915.88	166.19	1257.63	100.22	1.37
NDT RADSAF	C	910.22	8.50	1046.20	21.50	1.15
RM TT LLK	C	856.75	74.63	879.94	65.41	1.03
ADMIN/COUNS	O	817.90	399.53	1116.48	96.11	1.37
DP-SYS OPS	C	812.06	45.48	1064.56	12.00	1.31
SH-C CLERK	C	802.93	176.70	810.30	24.67	1.01
INST SHIPBD	C	744.03	452.51	850.70	217.51	1.14
IC-DRAI-DRT	C	689.19	50.67	987.60	47.67	1.43
EM WASH-EXT	C	688.96	78.25	738.94	97.50	1.07
AC&R CENTRL	C	664.42	95.51	750.78	78.00	1.13
MGMT/SUPV	C	658.51	1219.86	747.70	878.72	1.14
EM-16MM MT	C	632.12	221.00	781.64	177.50	1.24
SH-C LNDRY	C	517.36	56.50	723.34	65.00	1.40
RM QUAL CON	C	503.45	294.29	965.76	214.36	1.92
DRUG ADVISR	C	502.05	290.00	492.15	371.65	0.98
SK-FIN SYS	C	483.52	39.00	249.59	22.00	0.52
DSVETS	S	419.92	717.47	532.10	675.50	1.27
AC&R DRYAIR	C	401.77	96.44	381.06	17.00	0.95
SK-FOOD	C	326.78	95.00	604.18	22.00	1.85



Total Cost per Graduate 1974 vs 1975
foe all sixty Courses

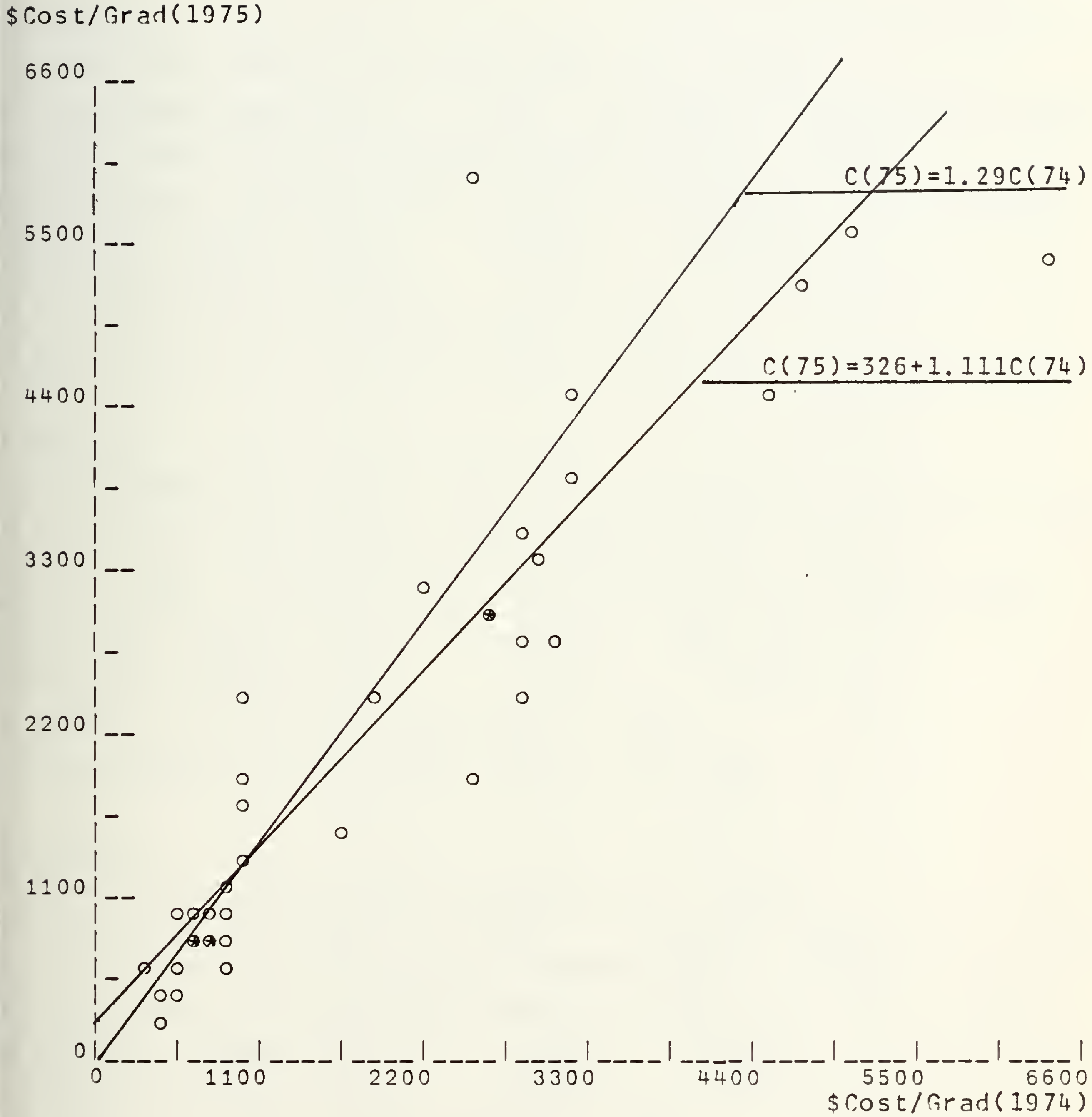
COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
RM-A	A	3672.74	1296.10	3129.56	2840.69	0.85
IC-A	A	2967.05	927.86	2373.89	1064.16	0.80
MR-A	A	2862.95	473.24	2806.80	505.39	0.98
HT-A-PH-2	A	2843.67	1633.11	2547.93	2393.85	0.90
EM-A	A	2562.32	869.29	1729.00	1169.38	0.67
CP-A	A	2082.54	655.21	2472.07	466.43	1.19
CK ASCCL	A	1791.90	436.02	2363.76	70.00	1.32
YN-A	A	1782.67	614.25	1515.78	151.00	0.85
SK-A AFLT	A	1745.11	963.88	1095.39	307.54	0.63
SK-A ASH	A	1604.88	164.07	1492.19	27.28	0.93
PC-A SCCL	A	1562.96	106.59	1170.61	175.95	0.75
PN-A	A	1552.27	541.80	1431.43	124.29	0.92
CM-A	A	958.81	506.64	1447.91	288.45	1.51



Total Cost per Graduate 1974 vs 1975

for A Schools

COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
NDT RAD OP	C	6402.84	54.38	5438.60	67.48	0.85
IC-AFSC	C	5084.15	47.60	5637.75	57.20	1.11
WELD NPPW	C	4707.92	116.54	5278.08	138.84	1.12
WELD NPPO	C	4504.52	64.72	4575.60	54.17	1.02
RM-TT MCD28	C	3163.11	268.24	4021.46	170.83	1.27
WELD PPHULL	C	3161.40	453.27	4423.12	480.52	1.40
RM-MORSE CD	C	3068.19	300.53	2872.53	534.38	0.94
NDT VMF	C	3006.82	86.97	3336.72	74.75	1.11
DRUG SPEC	C	2912.70	112.13	2540.83	96.23	0.87
AC & R	C	2888.64	323.51	2874.24	328.26	1.00
WELD HPPIPE	C	2880.03	263.08	3641.99	324.07	1.26
INTER/CLASS	C	2642.81	97.85	2987.03	101.37	1.13
IC-APS MT	C	2621.43	14.00	2947.90	11.70	1.12
DP SYS ANA	C	2546.25	16.40	1994.80	32.00	0.78
ET-C	C	2483.32	996.10	6000.45	554.83	2.42
IC-NC2 MD-2	C	2234.80	56.20	3205.25	37.20	1.43
DP IBM 360	C	1822.59	106.38	2416.88	75.19	1.33
NDT USEI	C	1625.98	50.72	1571.40	47.75	0.97
DP FORTRAN	C	1025.72	9.75	2449.84	4.37	2.39
DP PRG ASSY	C	1024.44	4.25	1854.12	10.83	1.81
NDT RI-N	C	1020.57	23.00	1420.12	53.00	1.39
NDT RI C	C	1009.74	21.67	1727.24	6.50	1.71
INST-NAVRES	C	930.84	26.00	559.69	26.00	0.60
SH-C BARBER	C	915.88	166.19	1257.63	100.22	1.37
NDT RADSAF	C	910.22	8.50	1046.20	21.50	1.15
RM TT LLK	C	856.75	74.63	879.94	65.41	1.03
DP-SYS OPS	C	812.06	45.48	1064.56	12.00	1.31
SH-C CLERK	C	802.93	176.70	810.30	24.67	1.01
INST SHIPBD	C	744.03	452.51	850.70	217.51	1.14
IC-DRAI-DRT	C	689.19	50.67	987.60	47.67	1.43
EM WASH-EXT	C	688.96	78.25	738.94	97.50	1.07
AC&R CENTRL	C	664.42	95.51	750.78	78.00	1.13
MGMT/SUPV	C	658.51	1219.86	747.70	878.72	1.14
EM-16MM MT	C	632.12	221.00	781.64	177.50	1.24
SH-C LNDRY	C	517.36	56.50	723.34	65.00	1.40
RM QUAL CON	C	503.45	294.29	965.76	214.36	1.92
DRUG ADVISR	C	502.05	290.00	492.15	371.65	0.98
SK-FIN SYS	C	483.52	39.00	249.59	22.00	0.52
AC&R DRYAIR	C	401.77	96.44	381.06	17.00	0.95
SK-FOOD	C	326.78	95.00	604.18	22.00	1.85



Total Cost per Graduate 1974 vs 1975

for C Schools

```
                TOTAL COST PER GRADUATE

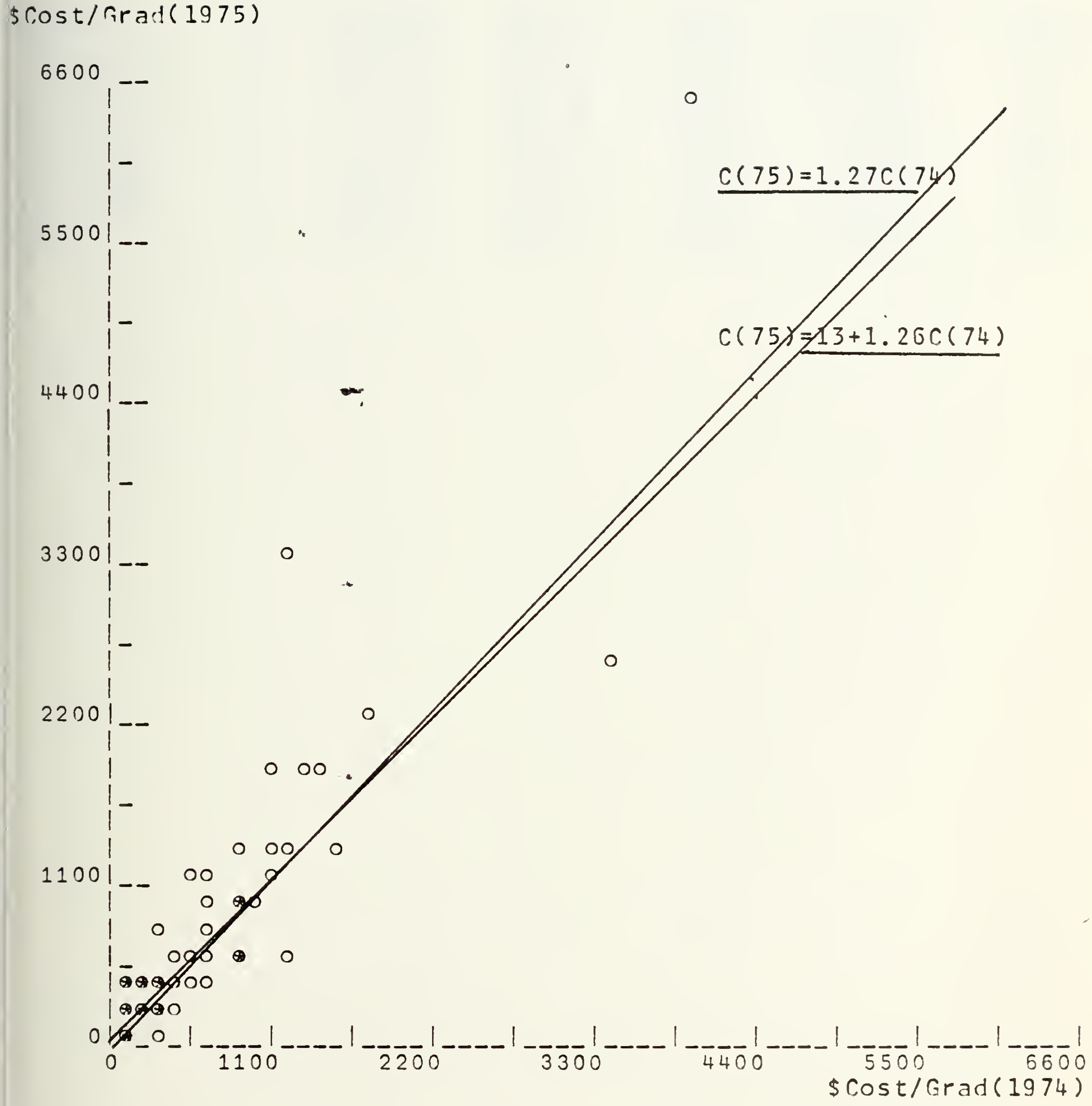

ALL COURSES
THE ARITHMETIC MEAN OF THE INDICATORS IS =  1.167
THE LASPEYRES INDICATOR IS  =1.081   THE PAASH INDICATOR IS = 1.014
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 1.095
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A = 52.648  FOR B = 1.083
CONFIDENCE INTERVAL FOR A    -151.512      256.809
CONFIDENCE INTERVAL FOR B        1.016        1.150
THE FVALUE = 5.717 THE TABLE VALUE = 2.390
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%

A SCHOOLS
THE ARITHMETIC MEAN OF THE INDICATORS IS =  0.946
THE LASPEYRES INDICATOR IS  =0.882   THE PAASH INDICATOR IS = 0.860
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 0.893
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A =424.290  FOR B = 0.717
CONFIDENCE INTERVAL FOR A    -152.840    1001.420
CONFIDENCE INTERVAL FOR B        0.463        0.970
THE FVALUE = 3.615 THE TABLE VALUE = 2.860
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%

C SCHOOLS
THE ARITHMETIC MEAN OF THE INDICATORS IS =  1.241
THE LASPEYRES INDICATOR IS  =1.409   THE PAASH INDICATOR IS = 1.290
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 1.111
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A =325.722  FOR B = 1.003
CONFIDENCE INTERVAL FOR A       32.535      618.909
CONFIDENCE INTERVAL FOR B        0.879        1.127
THE FVALUE = 4.645 THE TABLE VALUE = 2.440
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%
```

DIRECT COST PER GRADUATE

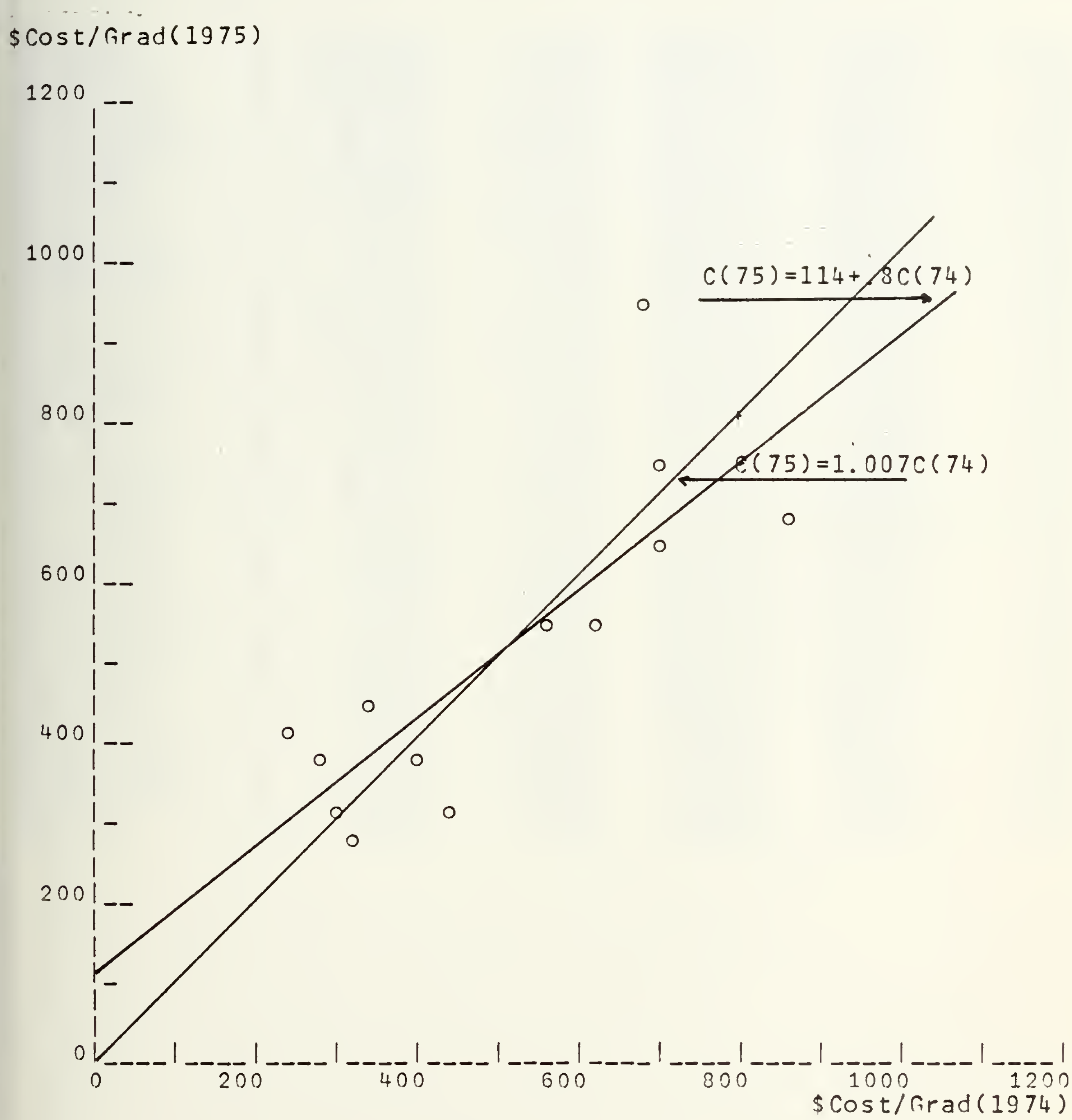
COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
ECCST	P	3991.47	93.04	6481.57	63.20	1.62
NDT RAC OP	C	3371.94	54.38	2583.03	67.48	0.77
RM-B	B	1565.27	334.30	1415.05	391.44	0.90
IC-APSC	C	1706.61	47.60	2368.55	57.20	1.39
WELD NFPW	C	1395.91	116.54	1939.85	138.84	1.39
WELD NFPC	C	1338.15	64.72	1978.80	54.17	1.48
RM-A	A	855.91	1296.10	698.68	2840.69	0.82
DIVE SECOND	F	1076.46	197.45	1324.01	193.95	1.23
RM-TT MCD28	C	1079.43	268.24	1854.71	170.83	1.72
WELD PPHULL	C	885.21	453.27	1065.17	480.52	1.20
RM-MORSE CD	C	882.48	300.53	690.43	534.38	0.78
NDT VMF	C	1079.49	86.97	1100.08	74.75	1.02
IC-A	A	706.55	927.86	649.14	1064.16	0.92
DRUG SPEC	C	942.05	112.13	1061.04	96.23	1.13
AC & R	C	924.76	323.51	972.49	328.26	1.05
WELD HPPIPE	C	933.63	263.08	1320.24	324.07	1.41
MR-A	A	691.06	473.24	754.38	505.39	1.09
HT-A-PH-2	A	565.63	1633.11	561.95	2393.85	0.99
INTER/CLASS	C	650.92	97.85	1128.27	101.37	1.73
IC-APS MT	C	322.49	14.00	362.80	11.70	1.12
EM-A	A	628.78	869.29	547.75	1169.38	0.87
DP SYS ANA	C	1170.35	16.40	689.55	32.00	0.59
ET-C	C	1214.48	996.10	3409.75	554.83	2.81
IC-NC2 MC-2	C	1181.72	56.20	1322.90	37.20	1.12
DP-A	A	687.20	655.21	939.62	466.43	1.37
DP IBM 360	C	557.02	106.38	1231.25	75.19	2.21
DK ASCCL	A	337.96	436.02	437.64	70.00	1.29
YN-A	A	407.12	614.25	392.28	151.00	0.96
SK-A AFLT	A	318.28	963.88	286.47	307.54	0.90
NDT LSEI	C	502.26	50.72	474.44	47.75	0.94
SK-A ASH	A	275.91	164.07	371.91	27.28	1.35
PC-A SCOL	A	449.99	106.59	329.28	175.95	0.73
PN-A	A	302.06	541.80	307.23	124.29	1.02
DIV SCUBA	F	408.78	162.32	560.03	165.92	1.37
EERECS	P	256.50	5419.08	286.50	6721.31	1.12
DP FORTRAN	C	117.95	9.75	383.52	4.37	3.25
DP PRG ASSY	C	119.76	4.25	290.70	10.83	2.43
NDT RI-N	C	317.03	23.00	444.24	53.00	1.40
NDT RI C	C	307.24	21.67	796.32	6.50	2.59
CM-A	A	239.55	506.64	432.67	288.45	1.81
INST-NAVRES	C	364.11	26.00	211.46	26.00	0.58
SH-C BARBER	C	292.31	166.19	477.84	100.22	1.63
NDT RADSAF	C	210.94	8.50	233.54	21.50	1.11
RM TT LLK	C	115.78	74.63	151.69	65.41	1.31
ADMIN/COUNS	C	125.71	399.53	470.39	96.11	3.74
DP-SYS OPS	C	120.80	45.48	192.40	12.00	1.59
SH-C CLERK	C	133.09	176.70	294.66	24.67	2.21
INST SHIPBD	C	144.99	452.51	202.35	217.51	1.40
IC-DRAI-DRT	C	92.24	50.67	114.90	47.67	1.25
EM WASH-EXT	C	190.63	78.25	289.62	97.50	1.52
AC&R CENTRL	C	194.75	95.51	220.96	78.00	1.13
MGMT/SUPV	C	120.66	1219.86	189.86	878.72	1.57
EM-16MM MT	C	271.24	221.00	420.64	177.50	1.55
SH-C LNDRY	C	167.00	56.50	380.70	65.00	2.28
RM QUAL CON	C	69.49	294.29	75.00	214.36	1.08
DRUG ADVISR	C	115.12	290.00	167.06	371.65	1.45
SK-FIN SYS	C	287.35	39.00	35.41	22.00	0.12
CSVETS	S	80.50	717.47	173.50	675.50	2.16
AC&R DRYAIR	C	136.99	96.44	94.59	17.00	0.69
SK-FCCC	C	131.53	95.00	390.00	22.00	2.97



Direct Cost per Graduate 1974 vs 1975

for all sixty Courses

COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
RM-A	A	855.91	1296.10	698.68	2840.69	0.82
IC-A	A	706.55	927.86	649.14	1064.16	0.92
MR-A	A	691.06	473.24	754.38	505.39	1.09
HT-A-FH-2	A	565.63	1633.11	561.95	2393.85	0.99
EM-A	A	628.78	869.29	547.75	1169.38	0.87
DP-A	A	687.20	655.21	939.62	466.43	1.37
DK ASCOL	A	337.96	436.02	437.64	70.00	1.29
YN-A	A	407.12	614.25	392.28	151.00	0.96
SK-A AFLT	A	318.28	963.88	286.47	307.54	0.90
SK-A ASH	A	275.91	164.07	371.91	27.28	1.35
FC-A SCOL	A	449.99	106.59	329.28	175.95	0.73
EN-A	A	302.06	541.80	307.23	124.29	1.02
CM-A	A.	239.55	506.64	432.67	288.45	1.81



Direct Cost per Graduate 1974 vs 1975

for A Schools

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COURSE NAME   TYPE   C(74 )     X(74)      C(75)      X(75)      I(74,75)


NDT RAD CP      C    3371.94      54.38    2583.03      67.48       0.77
IC-APSC         C    1706.61      47.60    2368.55      57.20       1.39
WELD NFPW       C    1395.91     116.54    1939.85     138.84       1.39
WELD NPPO       C    1338.15      64.72    1978.80      54.17       1.48
RM-TT MCC28     C    1079.43     268.24    1854.71     170.83       1.72
WELD FFHULL     C     885.21     453.27    1065.17     480.52       1.20
RM-MORSE CD     C     882.48     300.53     690.43     534.38       0.78
NDT VMF         C    1079.49      86.97    1100.08      74.75       1.02
DRUG SPEC       C     942.05     112.13    1061.04      96.23       1.13
AC & R          C     924.76     323.51     972.49     328.26       1.05
WELD HFPIPE     C     933.63     263.08    1320.24     324.07       1.41
INTER/CLASS     C     650.92      97.85    1128.27     101.37       1.73
IC-APS MT       C     322.49      14.00     362.80      11.70       1.12
DP SYS ANA      C    1170.35      16.40     689.55      32.00       0.59
ET-C            C    1214.48     996.10    3409.75     554.83       2.81
IC-NC2 MC-2     C    1181.72      56.20    1322.90      37.20       1.12
DP IBM 360      C     557.02     106.38    1231.25      75.19       2.21
NDT USEI        C     502.26      50.72     474.44      47.75       0.94
DP FORTRAN      C     117.95       9.75     383.52       4.37       3.25
DP PRG ASSY     C     119.76       4.25     290.70      10.83       2.43
NDT RI-N        C     317.03      23.00     444.24      53.00       1.40
NDT RI C        C     307.24      21.67     796.32       6.50       2.59
INST-NAVRES     C     364.11      26.00     211.46      26.00       0.58
SH-C BARBER     C     292.31     166.19     477.84     100.22       1.63
NDT RADSAF      C     210.94       8.50     233.54      21.50       1.11
RM TT LLK       C     115.78      74.63     151.69      65.41       1.31
DP-SYS OPS      C     120.80      45.48     192.40      12.00       1.59
SH-C CLERK      C     133.09     176.70     294.66      24.67       2.21
INST SHIPBD     C     144.99     452.51     202.35     217.51       1.40
IC-DRAI-DRT     C      92.24      50.67     114.90      47.67       1.25
EM WASH-EXT     C     190.63      78.25     289.62      97.50       1.52
AC&R CENTRL     C     194.76      95.51     220.96      78.00       1.13
MGMT/SUPV       C     120.66    1219.86     189.86     878.72       1.57
EM-16MM MT      C     271.24     221.00     420.64     177.50       1.55
SH-C LNDRY      C     167.00      56.50     380.70      65.00       2.28
RM QUAL CON     C      69.49     294.29      75.00     214.36       1.08
DRUG ADVISR     C     115.12     290.00     167.06     371.65       1.45
SK-FIN SYS      C     287.35      39.00      35.41      22.00       0.12
AC&R DRYAIR     C     136.99      96.44      94.59      17.00       0.69
SK-FOOD         C     131.53      95.00     390.00      22.00       2.97
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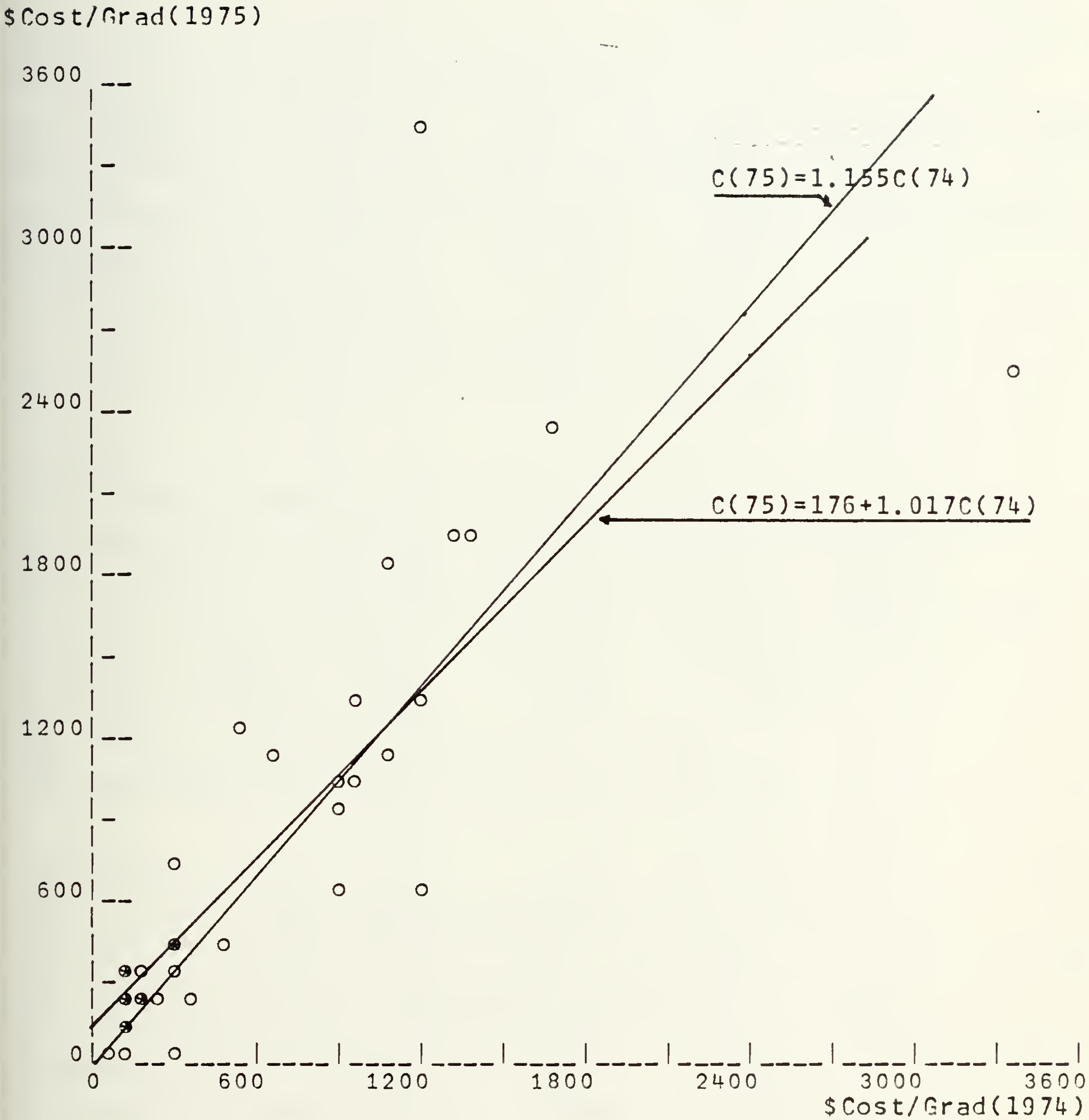

Direct Cost per Graduate 1974 vs 1975

for C Schools

DIRECT COST PER GRADUATE

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ALL COURSES
THE ARITHMETIC MEAN OF THE INDICATORS IS =  1.421
THE LASPEYRES INDICATOR IS  =1.303   THE PAASH INDICATOR IS = 1.146
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 1.274
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A = 13.161  FOR B = 1.265
CONFIDENCE INTERVAL FOR A    -114.059     140.381
CONFIDENCE INTERVAL FOR B       1.131       1.399
THE FVALUE =10.629 THE TABLE VALUE = 2.390
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%

A SCHOOLS
THE ARITHMETIC MEAN OF THE INDICATORS IS =  1.086
THE LASPEYRES INDICATOR IS  =0.994   THE PAASH INDICATOR IS = 0.932
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 1.007
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A =114.545  FOR B = 0.807
CONFIDENCE INTERVAL FOR A     -33.617     262.706
CONFIDENCE INTERVAL FOR B       0.530       1.085
THE FVALUE = 0.972 THE TABLE VALUE = 2.860
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%

C SCHOOLS
THE ARITHMETIC MEAN OF THE INDICATORS IS =  1.475
THE LASPEYRES INDICATOR IS  =1.725   THE PAASH INDICATOR IS = 1.498
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 1.155
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A =176.229  FOR B = 1.017
CONFIDENCE INTERVAL FOR A      15.755     336.703
CONFIDENCE INTERVAL FOR B       0.834       1.200
THE FVALUE = 3.648 THE TABLE VALUE = 2.440
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%
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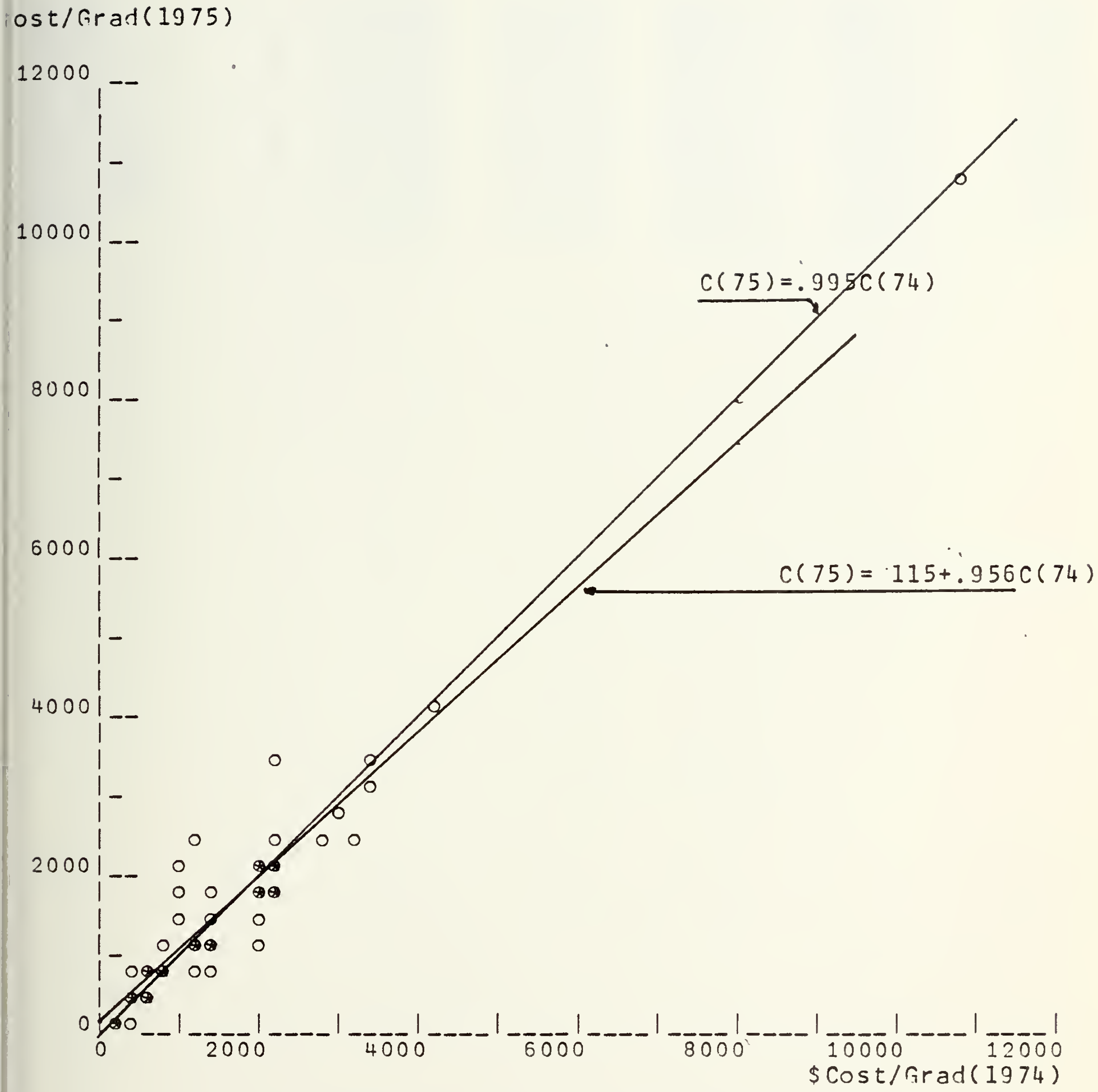
INDIRECT COST PER GRADUATE

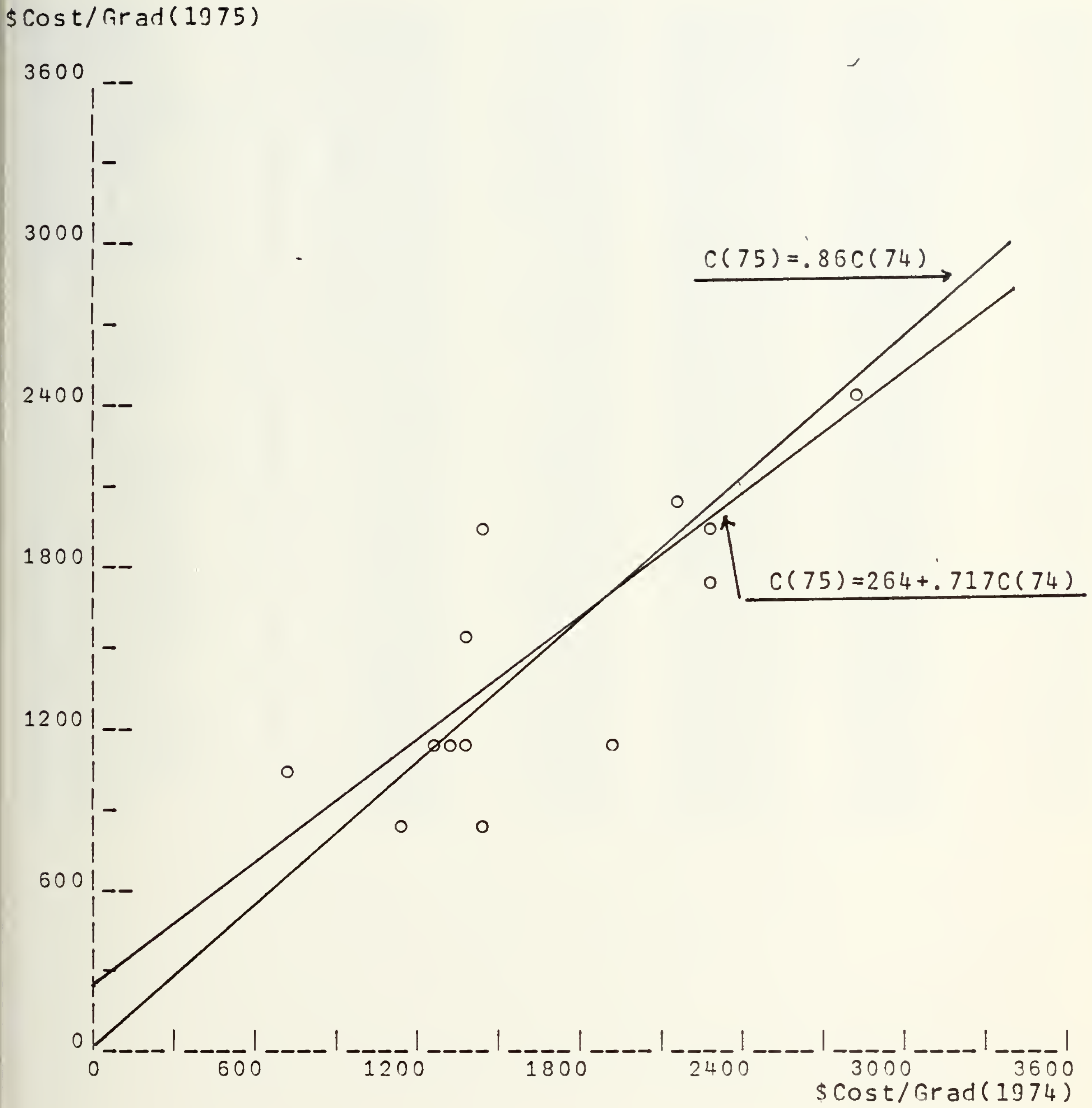
COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
BOOST	F	10814.45	93.04	10721.89	63.20	0.99
NDT RAD OP	C	3030.90	54.38	2855.57	67.48	0.94
RM-B	B	4150.97	334.30	4144.34	391.44	1.00
IC-APSD	C	3377.54	47.60	3269.20	57.20	0.97
WELD NPPW	C	3312.01	116.54	3338.23	138.84	1.01
WELD NPPC	C	3166.37	64.72	2596.80	54.17	0.82
RM-A	A	2816.83	1296.10	2430.88	2840.69	0.86
DIVE SECOND	F	2258.06	197.45	2059.07	193.95	0.91
RM-TT MOD28	C	2083.68	268.24	2166.75	170.83	1.04
WELD PPHULL	C	2276.19	453.27	3357.95	480.52	1.48
RM-MORSE CD	C	2185.70	300.53	2182.10	534.38	1.00
NDT VMP	C	1927.32	86.97	2236.64	74.75	1.16
IC-A	A	2260.50	927.86	1724.75	1064.16	0.76
DRUG SPEC	C	1970.64	112.13	1479.79	96.23	0.75
AC & R	C	1963.88	323.51	1901.75	328.26	0.97
WELD HPPIPE	C	1946.40	263.08	2321.75	324.07	1.19
MR-A	A	2171.89	473.24	2052.42	505.39	0.94
HT-A-PH-2	A	2278.04	1633.11	1985.98	2393.85	0.87
INTER/CLASS	C	1991.89	97.85	1858.76	101.37	0.93
IC-APS MT	C	2298.94	14.00	2585.10	11.70	1.12
EM-A	A	1933.54	869.29	1181.25	1169.38	0.61
DP SYS ANA	C	1375.90	16.40	1305.25	32.00	0.95
ET-C	C	1268.84	996.10	2590.70	554.83	2.04
IC-NC2 MD-2	C	1053.08	56.20	1882.35	37.20	1.79
DP-A	A	1395.34	655.21	1532.45	466.43	1.10
DP IBM 360	C	1265.57	106.38	1185.63	75.19	0.94
DK ASCOL	A	1453.94	436.02	1926.12	70.00	1.32
YN-A	A	1375.55	614.25	1123.50	151.00	0.82
SK-A AFLT	A	1426.83	963.88	808.92	307.54	0.57
NDT LSBI	C	1123.72	50.72	1096.96	47.75	0.98
SK-A ASH	A	1328.97	164.07	1120.28	27.28	0.84
FC-A SCOL	A	1112.97	106.59	841.33	175.95	0.76
EN-A	A	1250.21	541.80	1124.20	124.29	0.90
DIV SCUBA	F	838.46	162.32	896.38	165.92	1.07
BERECS	P	810.00	5419.08	927.85	6721.31	1.15
DP FORTRAN	C	907.77	9.75	2066.32	4.37	2.28
DP PRG ASSY	C	904.68	4.25	1563.42	10.83	1.73
NDT RI-N	C	703.54	23.00	975.88	53.00	1.39
NDT RI C	C	702.50	21.67	930.92	6.50	1.33
GM-A	A	705.16	506.64	1015.24	288.45	1.44
INST-NAVRES	C	566.73	26.00	348.23	26.00	0.61
SH-C BARBER	C	623.57	166.19	779.79	100.22	1.25
NDT RADSAF	C	740.97	8.50	728.25	21.50	0.98
RM TT LLK	C	692.19	74.63	646.09	65.41	0.93
ADMIN/COUNS	O	691.26	399.53	872.16	96.11	1.26
DP-SYS OPS	C	669.84	45.48	515.64	12.00	0.77
SH-C CLERK	C	599.03	176.70	648.35	24.67	1.08
INST SHIPBD	C	596.95	452.51	872.70	217.51	1.46
IC-DRAI-DRT	C	498.33	50.67	449.32	47.67	0.90
EM WASH-EXT	C	475.35	78.25	529.82	97.50	1.11
AC&R CENTRL	C	537.85	95.51	557.84	78.00	1.04
MGMT/SUPV	C	360.88	1219.86	361.00	878.72	1.00
EM-16MM MT	C	350.36	221.00	342.64	177.50	0.98
SH-C LNDRY	C	433.96	56.50	890.76	65.00	2.05
RM QUAL CON	C	386.93	294.29	325.09	214.36	0.84
DRUG ADVISR	C	196.17	290.00	214.18	371.65	1.09
SK-FIN SYS	C	339.42	39.00	358.60	22.00	1.06
CSVETS	S	264.78	717.47	286.47	675.50	1.08
AC&R DRYAIR	C	195.25	96.44	214.18	17.00	1.10
SK-FOOD	C	699.28	95.00	812.66	22.00	1.16



Indirect Cost per Graduate 1974 vs 1975

for all sixty Courses

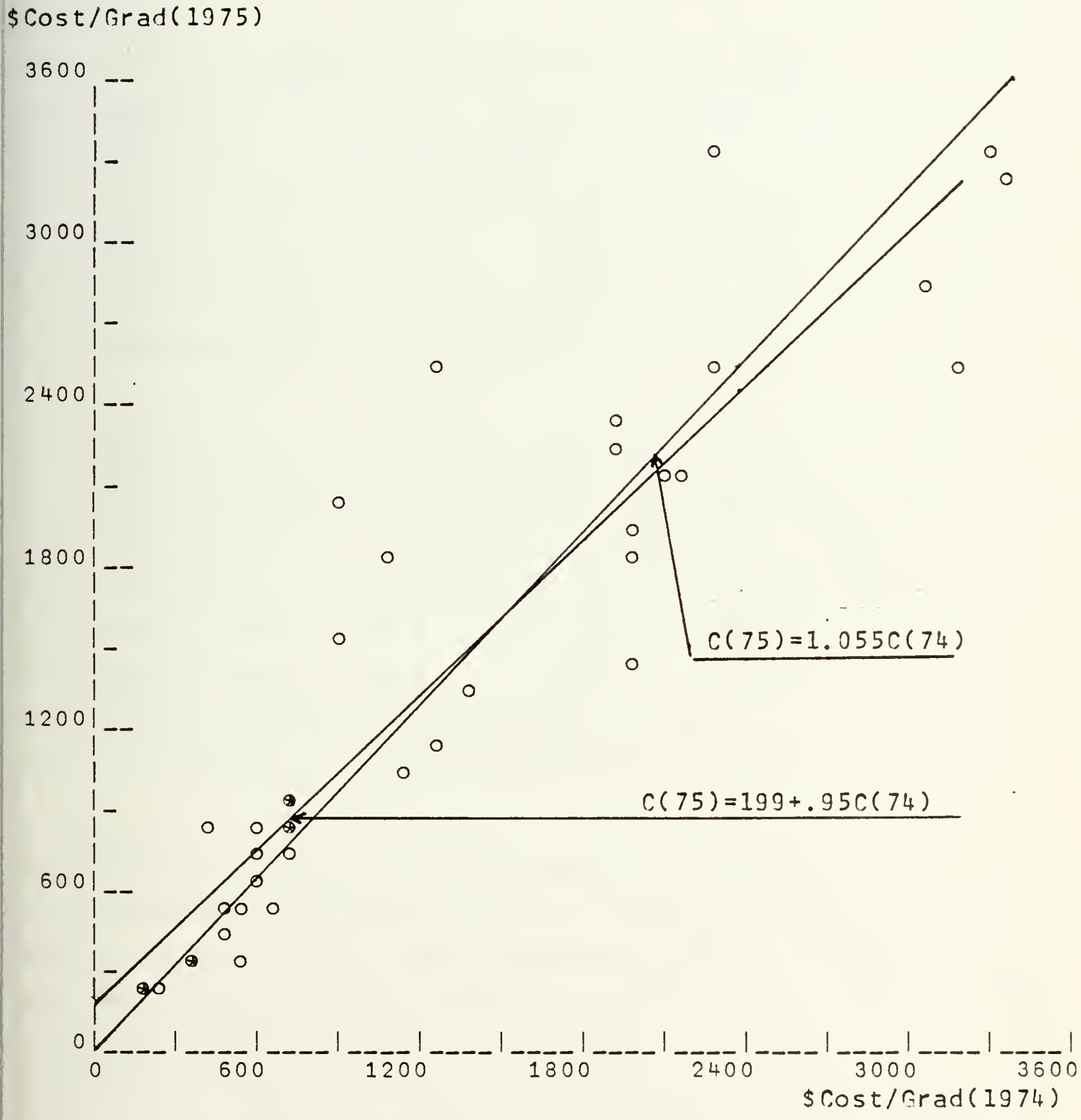
COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
RM-A	A	2816.83	1296.10	2430.88	2840.69	0.86
IC-A	A	2260.50	927.86	1724.75	1064.16	0.76
MR-A	A	2171.89	473.24	2052.42	505.39	0.94
HT-A-PH-2	A	2278.04	1633.11	1985.98	2393.85	0.87
EM-A	A	1933.54	869.29	1181.25	1169.38	0.61
DP-A	A	1395.34	655.21	1532.45	466.43	1.10
DK ASCOL	A	1453.94	436.02	1926.12	70.00	1.32
YN-A	A	1375.55	614.25	1123.50	151.00	0.82
SK-A AFLT	A	1426.83	963.88	808.92	307.54	0.57
SK-A ASH	A	1328.97	164.07	1120.28	27.28	0.84
FC-A SCOL	A	1112.97	106.59	841.33	175.95	0.76
PN-A	A	1250.21	541.80	1124.20	124.29	0.90
GM-A	A	705.16	506.64	1015.24	288.45	1.44



Indirect cost per Graduate 1974 vs 1975

for A Schools

COURSE NAME	TYPE	C(74)	X(74)	C(75)	X(75)	I(74,75)
NDT RAD OP	C	3030.90	54.38	2855.57	67.48	0.94
IC-AFSC	C	3377.54	47.60	3269.20	57.20	0.97
WELD NPPW	C	3312.01	116.54	3338.23	138.84	1.01
WELD NPPO	C	3166.37	64.72	2596.80	54.17	0.82
RM-TT MCC28	C	2083.68	268.24	2166.75	170.83	1.04
WELD FPHULL	C	2276.19	453.27	3357.95	480.52	1.48
RM-MORSE CD	C	2185.70	300.53	2182.10	534.38	1.00
NDT VMF	C	1927.32	86.97	2236.64	74.75	1.16
DRUG SPEC	C	1970.64	112.13	1479.79	96.23	0.75
AC & R	C	1963.88	323.51	1901.75	328.26	0.97
WELD HFPIPE	C	1946.40	263.08	2321.75	324.07	1.19
INTER/CLASS	C	1991.89	97.85	1858.76	101.37	0.93
IC-APS MT	C	2298.94	14.00	2585.10	11.70	1.12
DP SYS ANA	C	1375.90	16.40	1305.25	32.00	0.95
ET-C	C	1268.84	996.10	2590.70	554.83	2.04
IC-NC2 MC-2	C	1053.08	56.20	1882.35	37.20	1.79
DP IBM 360	C	1265.57	106.38	1185.63	75.19	0.94
NDT LSEI	C	1123.72	50.72	1096.96	47.75	0.98
DP FORTRAN	C	907.77	9.75	2066.32	4.37	2.28
DP PRG ASSY	C	904.68	4.25	1563.42	10.83	1.73
NDT RI-N	C	703.54	23.00	975.88	53.00	1.39
NDT RI C	C	702.50	21.67	930.92	6.50	1.33
INST-NAVRES	C	566.73	26.00	348.23	26.00	0.61
SH-C BARBER	C	623.57	166.19	779.79	100.22	1.25
NDT RADSAF	C	740.97	8.50	728.25	21.50	0.98
RM TT LLK	C	692.19	74.63	646.09	65.41	0.93
DP-SYS CPS	C	669.84	45.48	515.64	12.00	0.77
SH-C CLERK	C	559.03	176.70	648.35	24.67	1.08
INST SHIPBD	C	596.95	452.51	872.70	217.51	1.46
IC-DRAI-ORT	C	498.33	50.67	449.32	47.67	0.90
EM WASH-EXT	C	475.35	78.25	529.82	97.50	1.11
AC&R CENTRL	C	537.85	95.51	557.84	78.00	1.04
MGMT/SUPV	C	360.88	1219.86	361.00	878.72	1.00
EM-16MM MT	C	350.36	221.00	342.64	177.50	0.98
SH-C LNDRY	C	433.96	56.50	890.76	65.00	2.05
RM QUAL CON	C	386.93	294.29	325.09	214.36	0.84
DRUG ADVISR	C	196.17	290.00	214.18	371.65	1.09
SK-FIN SYS	C	339.42	39.00	358.60	22.00	1.06
AC&R DRYAIR	C	195.25	96.44	214.18	17.00	1.10
SK-FOOD	C	699.28	95.00	812.66	22.00	1.16



Indirect Cost per Graduate 1974 vs 1975

for C Schools

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                INDIRECT COST PER GRADUATE


ALL COURSES
THE ARITHMETIC MEAN OF THE INDICATORS IS =  1.091
THE LASPEYRES INDICATOR IS  =1.004   THE PAASH INDICATOR IS = 0.968
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 0.995
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A =115.882  FOR B = 0.956
CONFIDENCE INTERVAL FOR A        0.337     231.427
CONFIDENCE INTERVAL FOR B        0.903       1.010
THE FVALUE = 1.432 THE TABLE VALUE = 2.390
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%

A SCHOOLS
THE ARITHMETIC MEAN OF THE INDICATORS IS =  0.908
THE LASPEYRES INDICATOR IS  =0.849   THE PAASH INDICATOR IS = 0.839
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 0.860
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A =264.599  FOR B = 0.717
CONFIDENCE INTERVAL FOR A     -193.433     722.632
CONFIDENCE INTERVAL FOR B        0.455       0.979
THE FVALUE = 4.918 THE TABLE VALUE = 2.860
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%

C SCHOOLS
THE ARITHMETIC MEAN OF THE INDICATORS IS =  1.155
THE LASPEYRES INDICATOR IS  =1.256   THE PAASH INDICATOR IS = 1.192
FOR THE MODEL C(T)=C(T-1)*B THE ESTIMATE FOR B = 1.055
FOR THE MODEL C(T)=A+C(T-1)*B THE EST. A =199.476  FOR B = 0.951
CONFIDENCE INTERVAL FOR A       24.716     374.236
CONFIDENCE INTERVAL FOR B        0.838       1.064
THE FVALUE = 2.810 THE TABLE VALUE = 2.440
THE HYPOTHESIS IS A = 0, B=1, BOTH AT LEVEL 10%
```

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